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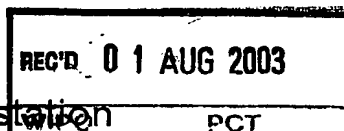
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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Molded integral optical lens component and optical lens arrangement comprising
the lens component

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Molded integral optical lens component and optical lens arrangement comprising the lens component

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BACKGROUND OF THE INVENTION

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The present invention relates to a molded integral optical lens component, comprising a central lens element having an optical axis and located centrally of a circumjacent mounting portion having spaced parallel surfaces extending perpendicularly to the said optical axis.

A molded integral optical lens component of the kind indicated above is known for example from a brochure (pages 153-157) published on the internet (www.thorlabs.com) by Thorlabs Inc., a company having offices in Newton, New Jersey, USA. This document describes a variety of integral plastic aspheric lens components manufactured by advanced molding technology to produce an all plastic near diffraction limited optical component for high volume applications, such as the bi-aspheric lens CAY033 ($f=3.3$ mm, 0.45 NA). These optics combine the performance of an aspheric lens with a low price. In order to be able to mount the optical component in an optical assembly, a mounting portion is provided surrounding the central lens element having spaced parallel surfaces extending perpendicular to an optical axis of the central lens element.

A common problem with optical elements is light scattering. Light that is randomly scattered within an integral optical element can cause different problems depending on the application. In lens elements stray light may cause ghost, light leakage or light loss in the overall optical system of which the lens element is a part. Ghost images and stray light arise due to inter-reflections of light from optical element surfaces which have non-zero reflection and transmission coefficients. Some of the incident light is transmitted through the surface of an element, while some is reflected from the same surface. The reflected light is propagated back to another component surface, then it is reflected there and eventually it propagates to the image plane or detector. These multiple reflections result in a ghost image and stray light.

Imaging lenses are designed to form an image of an object at a specific predetermined location in the image space. In a well designed system most of the light follows the predetermined designed light path. As discussed above, in some cases light may enter the system along other paths than the predetermined designed light path. This light

eventually reaches the image sensor as so called stray light or ghost images. In an integral optical lens component any additional portions of the lens component apart from the central lens element itself are optically connected to the lens element and may therefore contribute to any stray light problems as light may enter and exit these additional portions.

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SUMMARY OF THE INVENTION

It is an object of the invention to provide a useful molded integral optical lens component of the kind described in the introduction in which stray light is prevented at least to some extent to reach the image sensor so that a more ghost free image may be provided by the integral lens component. With this object in mind, the molded integral optical lens component according to the invention, comprising a central lens element having an optical axis and located centrally of a circumjacent mounting portion having spaced parallel surfaces extending perpendicularly to the said optical axis, has the novel inventive feature that at least one of the said spaced parallel surfaces is provided with a non random light scattering structure for coupling out light entering the said mounting portion, thus mitigating the above discussed problems of the prior art arrangements by coupling out stray light at the mounting portion.

An embodiment of the invention may be used according to claim 2. A satisfactory solution may be designed by selecting the inclinations of the light scattering surfaces for optimum performance. With an optical component according to the invention incorporating a lens element which in most cases will be shaped as a solid of revolution, a practical embodiment is provided by claim 3.

Good results have been achieved with an embodiment of the invention according claim 4 or 5, especially according to claim 6. Preferred is an embodiment according to claim 7 which has shown superior characteristics in a practical design of the optical element.

Highly preferred also is the embodiment of claim 8 and especially claim 9. Providing the light scattering structures by molding is very cost effective in the molded integral optical lens component of the invention. By molding the light scattering structures into the optical component, the overall dimensions of the component may remain the same while the method of mounting of the optical component in an optical system may also remain the same, due to the absence of any protrusions from the parallel surfaces of the mounting portion of the optical component.

The molded optical lens component according to the invention may be advantageously used in an arrangement of the invention according to claim 10. Any light coupled out of the optical lens component may thus be absorbed right where it leaves the optical component, thus preventing any undue problems caused by stray light elsewhere in the optical lens arrangement.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the present invention will become more apparent by referring to the following non-limiting description of a preferred embodiment given with reference to the accompanying drawings in which:

FIG. 1 is a side view in cross section of an optical lens assembly, comprising an integral optical lens component of the invention as well as a further optical lens component;

FIG. 2A - 2C are views of the optical assembly of Fig. 1, schematically indicating various typical light paths of light beams which would be reflected by surfaces of the assembly and contribute to undesirable stray light patterns in the imaging plane of the assembly if no random light scattering structure of the invention would have been provided;

FIG. 3 is a section of Fig. 1 on an enlarged scale showing details of the optical lens assembly and

Fig. 4 is a detail of Figures 1 and 3 on a greatly enlarged scale, illustrating how light is coupled out of the integral optical lens component of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a first integral optical lens component 1 is shown, manufactured from an optical grade plastic by molding, comprising a central lens element 3 having an optical axis 5 and located centrally of a circumjacent mounting portion 7 having spaced parallel surfaces 13A,B extending perpendicularly to the said optical axis 5. The mounting portion 7 comprises a flange portion 9 and a circumferential annular depending skirt portion 11.

This first lens component 1 is mounted on top of a second integral optical lens component 15, also manufactured from an optical grade plastic and comprising a central lens element 17, centered on the optical axis 5 of the first lens component 1. This second lens component 15 is provided with a skirt portion 19 for mounting in a suitable mount (not shown). The first and second optical lens components 1 and 15 respectively, together form an

optical lens assembly 21 for focussing a laser light beam, reflected from an optical disc of an optical disc player (not shown) in an imaging plane 24. Both the first and second optical lens components 1 and 15 respectively are formed as bodies of revolution, so that the skirt portion 11 of the first lens component 1 and the top portion of the second lens component 15 snugly fit into each other as general cylindrical portions, centered on the optical axis 5 of the two lens components 1 and 15 respectively.

In addition to the lens components 1 and 15, the lens assembly 21 comprises a washer shaped light absorbing means 25 which will be discussed later.

To prevent stray light from being projected onto the imaging plane 24, at least one and in the present case both of the said spaced parallel surfaces 13A,B of the first lens component 1 is/are provided with a non random light scattering structure 23A and 23B respectively for coupling out light entering the said mounting portion 7, which structures are to be discussed later below.

Referring now to figures 2A, 2B and 2C, various examples are shown of stray light beams entering the lens assembly 21 of Figure 1, as well as the effect that would be produced by stray light reaching the imaging plane 24 in the hypothetical situation in which it is assumed that no light scattering structures 23 A,B would be present in the lens assembly 21. Fig. 2A shows light beams 25 and 27 entering the lens element 3 of the lens component 1 from above and from the left. After entering the lens element 3 the light beams 25,27 are internally reflected from the lower surface 13B of the flange portion 9, the top surface 13A, the side surface of the skirt portion 11 and subsequently enters the second optical element 15. The beam then emerges at the lower surface of the lens element 17 of the second optical element and travels through air to the imaging plane 24. Fig. 2A, B and C should not be regarded as an exact representation of the various trajectory parts and angles etc. of the light beams 25 and 27, but merely as explanatory indication. Figures 2B and 2C show light beams 29 and 31 entering the lens element 3 of the first optical element 1 respectively and the paths followed by these beams until they impact on the imaging plane 24. After the detailed explanation of Fig. 2A, these figures will speak for themselves so that no further explanation will be given.

Referring to Fig.1 and more particularly to Fig. 3 and 4, it is shown that in the present embodiment both the said spaced parallel surfaces 13A and 13B are provided with a non random light scattering structure 23A, 23B respectively for coupling out light entering the said mounting portion 7. The non random light scattering structures 23A and 23B comprise indentations 33 including light scattering surfaces 35 and 36 having predetermined

inclinations α and β respectively relative to the said spaced parallel surfaces 13A, B. In the example shown the angle α may be roughly 40 degrees while the angle β may be roughly 90 degrees. The precise orientation, depth, spacing angles, etc. of the indentations may be determined by experiment and calculation. In the example shown the optical lens component 1 has a general over-all diameter of some 6 mm, the diameter of the convex upper lens portion of the central lens element 3 has a largest outer diameter of some 2.9 mm, the thickness of the flange portion 9 is some 0.55 mm and the depth of the indentations 33 is some 100 μm .

In the embodiment shown, the indentations comprise arrays of indentations of concentric circular indentations 33 centered on the optical axis 5 of the lens element 3. The indentations in the arrays have triangularly shaped cross sections in a plane including the said optical axis 5 of the lens element 1. Also all indentations 33 have identically shaped cross sections, the triangular shape being asymmetric relative to a local perpendicular.

In the embodiment shown the triangular shape of the indentations 33 comprises a right angled triangle having one cathetus 37 lying in the plane of the respective spaced parallel surface 13B of the said mounting portion 7, the second cathetus 36 being disposed on the side of the triangle facing the said central axis 5 of the optical lens component 1. The light scattering structures 23A, 23B are provided by molding into the molded optical lens component from an optical grade plastic as is well known *per se* from the prior art. In the present case the light scattering structures 23A, 23B are provided by integrally molding into the molded optical lens component 1.

Fig. 4 illustrates schematically how light rays indicated by broken lines and without reference numbers coming from different directions may reflect against internal or external surfaces of the indentations 33 and may be coupled out by passing through transparent surfaces of the indentations bordered by the hypothuse 35 and the cathetus 36. Washer shaped light absorbing means 25 is provided adjacent the non random light scattering structure 23B to absorb the light which is being coupled out of the optical lens component 1.

Thus a molded integral optical lens component has been described according to a best mode for carrying out the invention contemplated by the inventor at the time of writing the present specification. It will be appreciated by persons skilled in the art that the invention is not limited by what has been particularly described and shown above. Many modifications are possible without departing from the inventive concepts herein. For example a plurality of separate light scattering structures may be provided in different patterns at different locations and having indentation of different shapes. Instead of or in addition to

indentations, protrusions may be provided for purposes of coupling out light. The light scattering structures may be provided by mechanically removing material of the lens component after molding thereof or may be provided after molding by other methods such as hot stamping. All such and further embodiments not shown in the drawings and defined by

5 independent claim 1 are intended to be protected by the invention.

CLAIMS:

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1. Molded integral optical lens component, comprising a central lens element having an optical axis and located centrally of a circumjacent mounting portion having spaced parallel surfaces extending perpendicularly to the said optical axis, characterized in that at least one of the said spaced parallel surfaces is provided with a non random light scattering structure for coupling out light entering the said mounting portion.
5
2. Molded integral optical lens component according to claim 1, characterized in that the said non random light scattering structure comprises indentations including parallel light scattering surfaces having predetermined inclinations relative to the said spaced parallel surfaces.
10
3. Molded integral optical lens component according to claim 2, characterized in that the indentations comprise at least one array of indentations including concentric circular indentations centered on the said optical axis of the lens element.
15
4. Molded integral optical lens component according to claim 2 or 3, characterized in that the indentations in at least one array have triangularly shaped cross sections in a plane including the said optical axis of the lens element.
- 20 5. Molded integral optical lens component according to claim 4, characterized in that in at least one array all indentations have identically shaped cross sections.
6. Molded integral optical lens component according to claim 4 or 5, characterized in that the triangular shape is asymmetric relative to a local perpendicular.
25
7. Molded integral optical lens component according to claim 6, characterized in that the triangular shape comprises a right angled triangle having one cathetus lying in the plane of the respective spaced parallel surface of the said mounting portion, the second cathetus being disposed on the side of the triangle facing the said central axis.

8. Optical lens component according to any of claims 1-7, characterized in that the light scattering structure is provided by molding with the molded optical lens component.
- 5 9. Optical lens component 1 according to claims 8, characterized in that the light scattering structure is provided by molding into the molded optical lens component.
10. Optical lens arrangement, comprising an optical lens component according to any of claims 1-9, characterized in that light absorbing means are provided adjacent at least
- 10 one non random light scattering structure.

ABSTRACT:

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A molded integral optical lens component (1) comprises a central lens element (3) having an optical axis (5) and located centrally of a circumjacent mounting portion (7) having spaced parallel surfaces (13A, 13B) extending perpendicularly to the said optical axis. At least one of the said spaced parallel surfaces is provided with a non random light scattering structure (23A, 23B) for coupling out light entering the said mounting portion. The non random light scattering structure may comprise indentations including parallel light scattering surfaces having predetermined inclinations relative to the said spaced parallel surfaces, such as array of indentations including concentric circular indentations centered on the said optical axis of the lens element.

The light scattering structure is preferably provided by molding with the molded optical lens component, preferably into the molded optical lens component.

Also provided is an optical lens arrangement comprising an optical lens component according to the invention and light absorbing means provided adjacent at least one non random light scattering structure.

Fig. 1

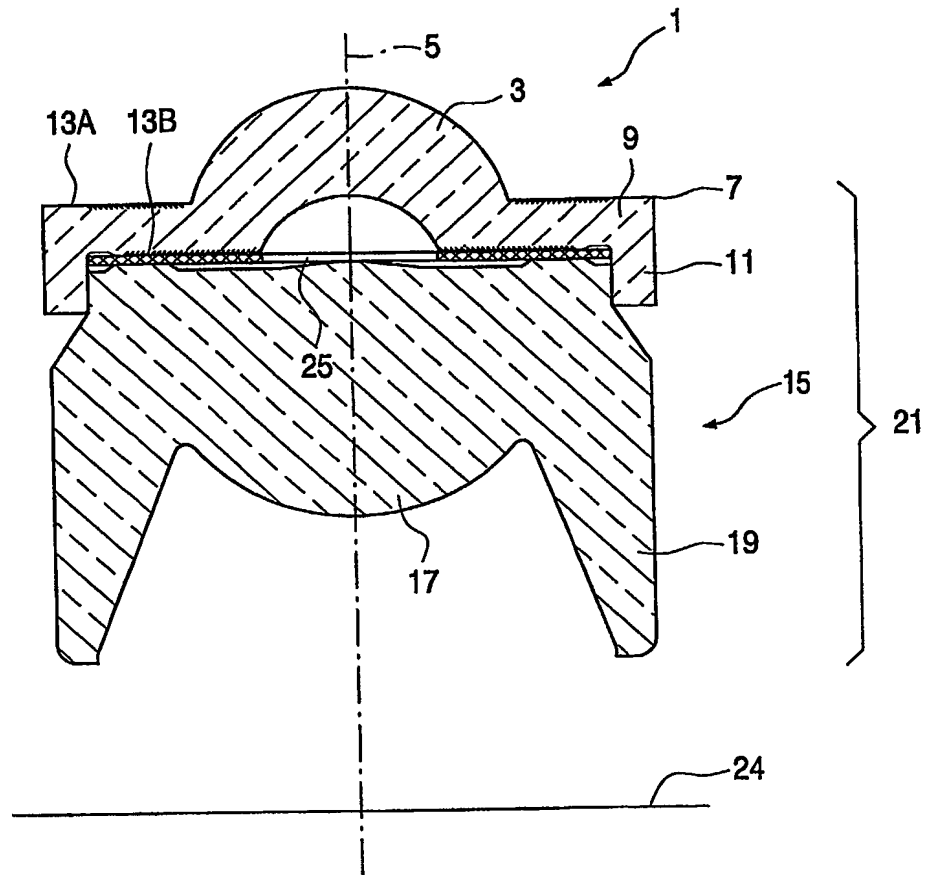
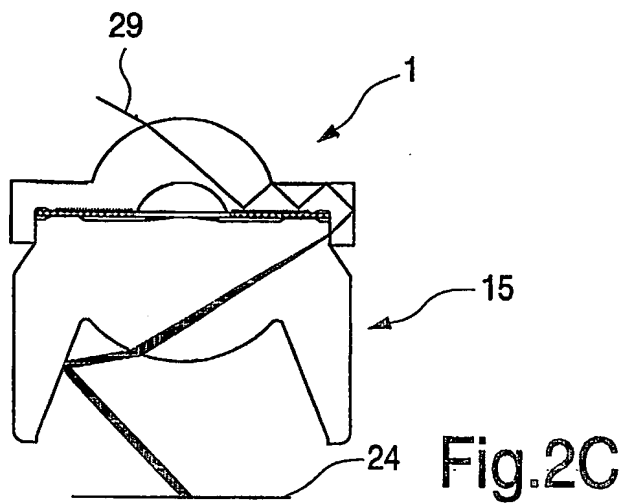
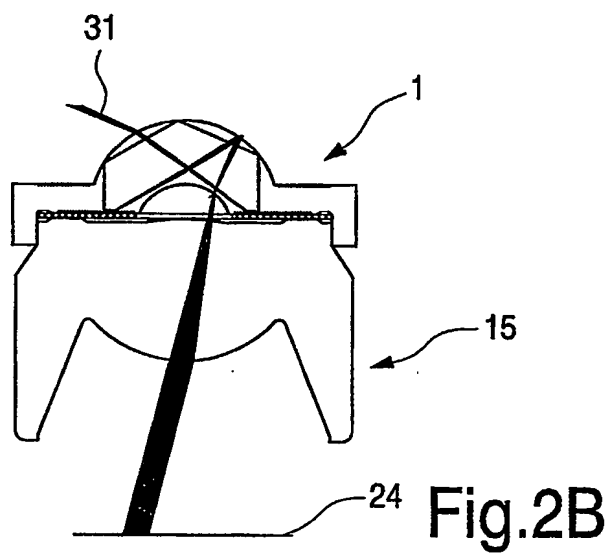
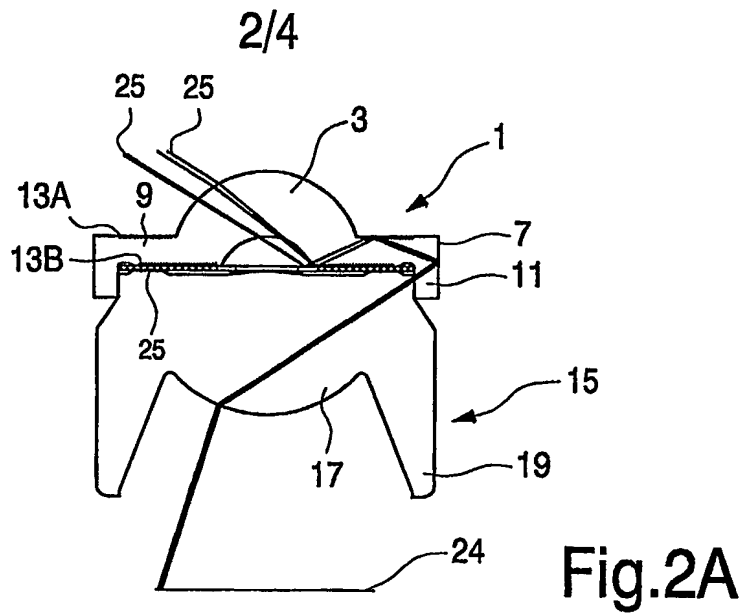


Fig.1



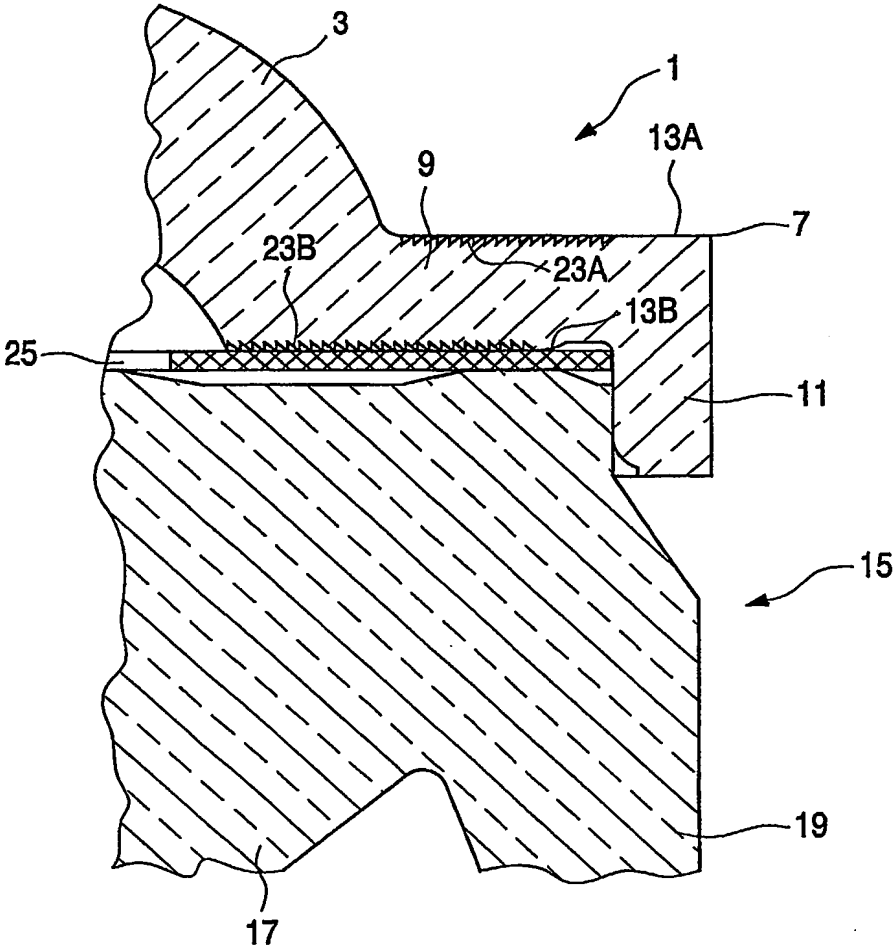


Fig.3

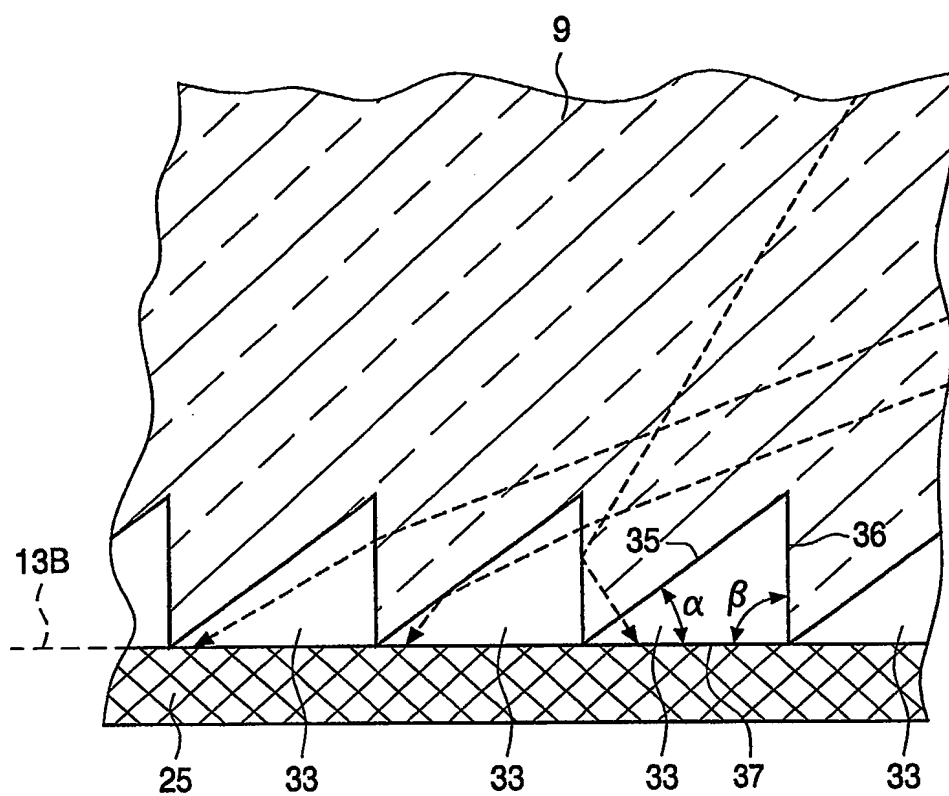


Fig.4

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